

DESCRIPTION

SOLID-STATE IMAGE PICKUP DEVICE AND  
RADIATION IMAGE PICKUP DEVICE

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TECHNICAL FIELD

The present invention relates in general to a radiation image pickup device for detecting radiation such as X-rays, ~~(but including within this term, for purposes of this application, beams of alpha rays, or beta particles, as well as~~ ~~rays, or gamma rays)~~, the device being applied to a medical image diagnosis system, a non-destructive inspection system, an analyzer or the like. More particularly, the invention relates to a solid-state image pickup device for use in a flat panel detector (hereinafter referred to as "an FPD" for short when applicable). The FPD is obtained by combining a sensor array constituted by a sensor device using non-monocrystalline silicon, e.g., amorphous silicon (hereinafter referred to as "a-Si" for short) and TFT elements, with a phosphor for converting radiation into visible rays of light, etc.

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BACKGROUND ART

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In recent years, the technique for TFTs for liquid crystal display devices has progressed, and servicing for information infrastructure has been made satisfactory. Thus, at the present time, the FPD is proposed, and even in the medical image field, the FPD can have a large area and digitization of the FPD is attained.

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This FPD is adapted to read out a radiation image in an instant to display the radiation image ~~thus read out~~ on a display device simultaneously, and an image can be directly fetched in the form of digital information from the FPD. Thus,

the FPD has the feature that handling and management is convenient in the safekeeping of data, ~~or and in the processing~~ and transfer of data. In addition, it was verified that though the characteristics such as sensitivity depend on photographing conditions, the characteristics are equal to or superior to those in a conventional screen film photographing method or a computed radiography photographing method.

Commercialization of the FPD has been attained. On the other hand, various proposals for the FPD have been made for the purpose of aiming at further enhancing the sensitivity. For example, in a ~~paper by report made in a literature of~~ L.E. Antonuk et al., in the journal "~~SPIE Medical Imaging VI~~" *SPIE Medical Imaging VI*, February, pp. 23 to 27, 1992, there is disclosed a structure in which a sensor element is formed on a TFT element. In this ~~related art~~ example, adoption of the above-mentioned structure allows an open area ratio of the sensor element to be increased to make enhancement of sensitivity possible. In addition, it is described that since the TFT element is disposed right under the sensor element, an unnecessary parasitic ~~capacity-capacitance~~ is formed, and hence a grounded plane is ~~disposed~~ provided.

In addition, in a proposal made in a ~~literature of the specification in~~ U.S. Patent No. 5,498,880, granted to DuPont, likewise, there is shown a structure in which in order to increase an open area ratio, a sensor element is formed on a TFT element. In this ~~related art~~ example, there is adopted ~~the a~~ structure in which an electrode connected to a source/drain electrode of the TFT covers the TFT element, and also ~~becomes~~ serves as a separate electrode of the sensor element.

On the other hand, in a proposal ~~as well in a literature of~~ Japanese Patent Application Laid-Open No. 2000-156522, filed by Canon Kabushiki Kaisha, there is shown a structure in which for the purpose of aiming at increasing an open area ratio, a sensor element is formed above a TFT element. In this ~~related art~~

example, there is adopted ~~the a~~ structure in which the sensor element is formed over the TFT element, ~~but spaced from the latter by through~~ an interlayer film.

However, in the above-mentioned FPD having ~~the structure in which the~~ sensor element ~~is~~ formed on the TFT element, the separate electrode of the sensor element acts as a back gate electrode of the TFT element. Hence, a problem ~~such~~ ~~as of~~ generation of a leakage current of the TFT element is caused ~~due to by~~ the fluctuation in electric potential of the separate electrode. Such a problem appears in the form of degradation of quality of ~~an the~~ image.

In a case where for example, an area having a large sensor output signal, and an area having a small sensor output signal are disposed adjacent to each other, ~~such crosstalk as to that blurs the a~~ boundary between these areas appears. In addition, there is caused a problem that ~~a~~ sensor saturation output is decreased, ~~reducing the to reduce a~~ dynamic range.

#### DISCLOSURE SUMMARY OF THE INVENTION

The present invention has been made in the light of the foregoing problems, and it is, therefore, an object of the present invention to make it possible that even when an electric potential of a separate electrode of a sensor element disposed above a switching element fluctuates, the fluctuation in characteristics due to generation of a leakage current of the switching element is suppressed to attain enhancement of sensitivity.

In order to solve the above-mentioned problems, according to the present invention, there is provided a solid-state image pickup device including a plurality of photoelectric conversion elements and a plurality of switching elements, characterized in that the photoelectric conversion element is formed above at least one switching element, and a shielding electrode layer is disposed between the switching elements and the photoelectric conversion elements.

Further, according to the present invention, there is provided a radiation image pickup device including a radiation conversion layer for directly converting radiation into electric charges, and a plurality of switching elements, characterized in that the radiation conversion layer is formed above one or more switching  
5 elements, and a shielding electrode layer is disposed between the switching elements and the radiation conversion layer.

According to the present invention, the shielding layer is provided so as to be interposed between the switching element and the sensor portion formed above the switching element, whereby even when an electric potential of a separate  
10 electrode of the sensor element disposed above the switching element fluctuates, the fluctuation in characteristics due to generation of a leakage current of the switching element can be suppressed to attain enhancement of sensitivity.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying  
15 drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a  
20 part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1 is a schematic equivalent circuit diagram of pixels disposed in matrix of  $3 \times 3$  of a solid-state image pickup device according to Embodiment 1 of the present invention;

25 FIG. 2 is a schematic plan view of one pixel of the solid-state image pickup device according to Embodiment 1 of the present invention;

FIG. 3 is a schematic plan view of four pixels of the solid-state image

pickup device according to Embodiment 1 of the present invention;

FIG. 4 is a schematic cross-sectional view of the solid-state image pickup device according to Embodiment 1 of the present invention;

FIG. 5 is a schematic equivalent circuit diagram of pixels disposed in matrix of  $3 \times 3$  of a solid-state image pickup device according to Embodiment 2 of the present invention;

FIG. 6 is a schematic plan view of one pixel of the solid-state image pickup device according to Embodiment 2 of the present invention;

FIG. 7 is a schematic plan view of four pixels of the solid-state image pickup device according to Embodiment 2 of the present invention;

FIG. 8 is a schematic ~~cross-sectional~~ cross-sectional view of the solid-state image pickup device according to Embodiment 2 of the present invention;

FIG. 9 is a schematic equivalent circuit diagram of pixels disposed in matrix of  $3 \times 3$  of a solid-state image pickup device according to Embodiment 3 of the present invention;

FIG. 10 is a schematic plan view of one pixel of the solid-state image pickup device according to Embodiment 3 of the present invention;

FIG. 11 is a schematic plan view of four pixels of the solid-state image pickup device according to Embodiment 3 of the present invention;

FIG. 12 is a schematic ~~cross-sectional~~ cross-sectional view of the solid-state image pickup device according to Embodiment 3 of the present invention; and

FIG. 13 is a schematic ~~cross-sectional~~ cross-sectional view of a radiation image pickup device according to Embodiment 4 of the present invention.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Next, embodiments of the present invention will hereinafter be described

with reference to the accompanying drawings.

#### Embodiment 1

Description will hereinafter be given with respect to a solid-state image pickup device using a MIS type photodiode (hereinafter referred to as “a PD” for  
5 short when applicable) according to Embodiment 1 of the present invention.

FIG. 1 is a schematic equivalent circuit diagram of pixels disposed in matrix of  $3 \times 3$  of a solid-state image pickup device according to Embodiment 1, FIG. 2 is a schematic plan view of one pixel of the solid-state image pickup device according to this embodiment, FIG. 3 is a schematic plan view of four pixels of the  
10 solid-state image pickup device according to this embodiment, and FIG. 4 is a schematic cross sectional view of the solid-state image pickup device according to this embodiment.

In FIGS. 1 and 2, reference numeral 101 designates a MIS type PD as a photoelectric conversion element (sensor element); reference numeral 102  
15 designates a transferring TFT as a switching element (thin film transistor); reference numeral 103 designates a transferring TFT driving wiring; reference numeral 104 designates a signal line; reference numeral 105 designates a sensor biasing wiring; reference numeral 106 designates a shielding wiring (GND wiring); reference numeral 107, a source/drain electrode layer of the transferring  
20 TFT 102; reference numeral 108, a contact hole; and 109, a sensor lower electrode layer.

In FIG. 4, reference numeral 110 designates an insulating substrate made of glass or the like; reference numeral 111 designates a gate insulating film made of SiN, SiO<sub>2</sub> or the like; reference numeral 112 designates a first amorphous  
25 semiconductor layer made of a-Si or the like; reference numeral 113 designates a first n<sup>+</sup> type layer (ohmic contact layer); reference numerals 114 and 115 each designate an interlayer insulating film made of SiN, SiO<sub>2</sub>, benzocyclobutene

(BCB), Polyimide (PI) or the like; reference numeral 116 designates an insulating film made of SiN, SiO<sub>2</sub> or the like; reference numeral 117, a second amorphous semiconductor layer made of a-Si or the like; reference numeral 118, a second n<sup>+</sup>-type layer (hole blocking layer) made of microcrystalline silicon, a-Si or the like; reference numeral 119, a transparent electrode layer made of ITO, SnO<sub>2</sub> or the like; reference numeral 132, a passivation layer made of SiN, PI or the like; reference numeral 134, an adhesion layer; and 135, a phosphor layer acting as a wavelength conversion layer.

Note that, in FIG. 4, reference numerals 103, 105 and 106 designate a gate electrode layer, a sensor biasing electrode layer, and a shielding electrode layer, respectively.

The insulating film 116, the second amorphous semiconductor layer 117 made of a-Si or the like, and the second n<sup>+</sup>-type layer 118 constitute a photoelectric conversion layer of the MIS type PD 101. The gate electrode layer 103, the gate insulating film 111 made of SiN, SiO<sub>2</sub> or the like, the first amorphous semiconductor layer 112 made of a-Si or the like, the first n<sup>+</sup>-type layer (ohmic contact layer) 113, and the source/drain electrode layer 107 for the transferring TFT constitute the transferring TFT 102. The photoelectric conversion layer is formed above the transferring TFT 102, and hence the transferring TFT 102 is covered with the photoelectric conversion layer.

The shielding electrode layer 106 is disposed so as to be interposed between the MIS type PD 101 and the transferring TFT 102.

Radiation such as X-rays is made incident from an upper side above in the paper of FIG. 2, to be converted into visible rays of light through the phosphor layer 135. The resultant rays are then converted into electric charges by the MIS type PD 101 to be accumulated in the MIS-type PD 101. Thereafter, the transferring TFT 102 is operated by a TFT driving circuit through the transferring

TFT driving wiring 103 to transfer these accumulated electric charges to the signal line 104 connected to one of the source electrode and the drain electrode of the transferring TFT 102 to be processed in the signal processing circuit, and the resultant analog signal is then subjected to A/D conversion in the A/D conversion circuit, to be outputted. ~~At this time, as in this processing the~~ electric potential of the shielding wiring 106 is fixed to a constant electric potential such as GND at all times.

In this embodiment, the shielding wiring 106 disposed below the sensor element is grounded. As a result, even if ~~as the~~ electric potential of a separate electrode of the sensor element fluctuates, ~~the~~ fluctuation in characteristics due to generation of a leakage current of the TFT element can be suppressed, to allow enhancement of sensitivity to be attained. In addition, since the shielding wiring 106 does not overlap the signal line 104 at all, no parasitic ~~capacity-capacitance~~ is formed between the shielding wiring 106 and the signal line 104, and hence degradation of the sensor sensitivity can also be suppressed.

In this embodiment, there has been shown the specific case where ~~a the~~ width of the shielding wiring 106 is identical to ~~a the~~ channel width-length of the TFT. However, in order to reduce a ~~capacity-capacitance~~ in a cross portion between the transferring TFT driving wiring 103 and the shielding wiring 106, it is also possible to use a wiring having a width smaller than the channel ~~width-length~~ in the cross portion between the transferring TFT driving wiring 103 and the shielding wiring 106.

In addition, the shielding wiring 106 has only to be held at a constant electric potential, and hence it is also possible to set the electric potential of the shielding wiring 106 to any constant electric potential other than GND. Since ~~the~~ resistance of the shielding wiring 106 may be high, a wiring made of a high melting point metal such as molybdenum (Mo), chromium (Cr), titanium (Ti),



tungsten (W), or molybdenum-tungsten (MoW) can be used as the shielding wiring

106. ~~This makes it possible to reduce. As a result, a limitations on the to a~~

manufacturing process ~~can to be used~~reduced. Moreover, of the layer including

the gate electrode, the layer including the source/drain electrode, the layer

5 including the shielding electrode, and the layer including the sensor biasing

electrode, the shielding electrode layer is formed as the thinnest wiring ~~in order to~~

reduce a difference in level and to reduce a difference in level of the sensor portion

formed above the shielding wiring 106, resulting in improving the yield. This is

because ~~as the~~ electrical resistance value of the shielding electrode layer may be

10 larger than that of each of other electrode layers.

#### Embodiment 2

Description will hereinafter be given with respect to a solid-state image  
pickup device using a MIS-type PD according to Embodiment 2 of the present  
invention.

15 FIG. 5 is a schematic equivalent circuit diagram of pixels disposed in  
matrix of  $3 \times 3$  of a solid-state image pickup device according to Embodiment 2,  
FIG. 6 is a schematic plan view of one pixel of the solid-state image pickup device  
according to this embodiment, FIG. 7 is a schematic plan view of four pixels of the  
solid-state image pickup device according to this embodiment, and FIG. 8 is a  
20 schematic cross-sectional view of the solid-state image pickup device according to  
this embodiment.

The same reference numerals as those in Embodiment 1 indicate the same  
components.

In FIGS. 5 and 6, reference numeral 101 designates a MIS type PD;  
25 reference numeral 102 designates a transferring TFT; reference numeral 103  
designates a transferring TFT driving wiring; reference numeral 104 designates a  
signal line; reference numeral 105 designates a sensor biasing wiring; reference

numeral 106 designates a shielding wiring (GND wiring); reference numeral 108, a contact hole; reference numeral 109, a sensor lower electrode layer; reference numeral 120, a resetting TFT as a switching element; reference numeral 121, a resetting TFT driving wiring; and 126, a reset wiring.

5 In FIG. 8, reference numeral 110 designates an insulating substrate made of glass or the like; reference numeral 111 designates a gate insulating film made of SiN, SiO<sub>2</sub> or the like; reference numeral 112 designates a first amorphous semiconductor layer made of a-Si or the like; reference numeral 113 designates a first ~~n<sup>+</sup>-type~~ ~~n<sup>+</sup>-type~~ layer (ohmic contact layer); reference numerals 114 and 115  
10 each designate an interlayer insulating film made of SiN, SiO<sub>2</sub>, ~~b~~ Benzocyclobutene (BCB), ~~p~~ Polyimide (PI) or the like; reference numeral 116 designates an insulating film made of SiN, SiO<sub>2</sub> or the like; reference numeral 117, a second amorphous semiconductor layer made of a-Si or the like; reference numeral 118, a second ~~n<sup>+</sup>-type~~ ~~n<sup>+</sup>-type~~ layer (hole blocking layer) made of microcrystalline silicon, a-Si or  
15 the like; reference numeral 119, a transparent electrode layer made of ITO, SnO<sub>2</sub> or the like; reference numeral 107, a source/drain electrode layer of the transferring TFT 102; reference numeral 122, a source/drain electrode layer of the resetting TFT; reference numeral 132, a passivation layer made of SiN, PI or the like; reference numeral 134, an adhesion layer; and 135, a phosphor layer.

20 Note that, in FIG. 8, reference numerals 103 and 121 each designate a gate electrode layer, reference numeral 105 designates a sensor biasing electrode layer, and reference numeral 106 designates a shielding electrode layer.

The insulating film 116, the second amorphous semiconductor layer 117 made of a-Si or the like, and the second ~~n<sup>+</sup>-type~~ ~~n<sup>+</sup>-type~~ layer 118 constitute a  
25 photoelectric conversion layer of the MIS-~~...~~type PD 101. The gate electrode layer 103, the gate insulating film 111 made of SiN, SiO<sub>2</sub> or the like, the first amorphous semiconductor layer 112 made of a-Si or the like, the first ~~n<sup>+</sup>-type~~ ~~n<sup>+</sup>-type~~ layer

(ohmic contact layer) 113, and the source/drain electrode layer 107 for the transferring TFT constitute the transferring TFT 102. The gate electrode layer 121, the gate insulating film 111 made of SiN, SiO<sub>2</sub> or the like, the first amorphous semiconductor layer 112 made of a-Si or the like, the first ~~n<sup>+</sup>-type~~ ~~p<sup>+</sup>-type~~ layer (ohmic contact layer) 113, and the source/drain electrode layer 122 of the resetting TFT constitute the resetting TFT 120. The photoelectric conversion layer is formed above the transferring TFT 102 and the resetting TFT 120, and hence both the TFTs are covered with the photoelectric conversion layer.

The shielding electrode layer 106 is disposed so as to be interposed between the MIS type PD 101 and the transferring TFT 102, and between the MIS-type PD 101 and the resetting TFT 120.

Radiation such as X-rays is made incident from ~~above an upper side in the paper of~~ FIG. 6 to be converted into visible rays of light through the phosphor layer 135. The resultant rays are then converted into electric charges by the MIS-type PD 101 to be accumulated in the MIS-type PD 101. Thereafter, the transferring TFT 102 is operated by the transferring TFT driving wiring 103 connected to a TFT driving circuit to transfer these accumulated electric charges to the signal line 104 connected to one of the source electrode and the drain electrode of the transferring TFT 102 to be processed in the signal processing circuit, and the resultant analog signal is then subjected to A/D conversion in the A/D conversion circuit, to be outputted. Thereafter, the resetting TFT 120 is operated by the resetting TFT driving wiring 121 connected to the signal processing circuit to reset the MIS-type PD 101. ~~At this time, an~~ ~~In this processing the~~ electric potential of the shielding wiring 106 is fixed to a constant electric potential such as GND at all times.

In this embodiment, the shielding wiring 106 disposed below the sensor element is grounded. As a result, even if ~~an the~~ electric potential of a separate

electrode of the sensor element fluctuates, ~~the fluctuation in characteristics due to~~  
generation of a leakage current of the TFT element can be suppressed, to allow  
enhancement of sensitivity to be attained. In addition, since the shielding wiring  
106 does not overlap the signal line 104 at all, no parasitic ~~capacity-capacitance~~ is  
5 formed between the shielding wiring 106 and the signal line 104, and hence  
degradation of the sensor sensitivity can also be suppressed.

In this embodiment, there has been shown the specific case where ~~the~~  
width of the shielding wiring 106 is identical to ~~the channel width-length~~ of the  
TFT. However, in order to reduce ~~a capacity-the capacitance~~ in a cross portion  
10 between the respective TFT driving wirings, it is also possible to use a wiring  
having a width smaller than the channel ~~width-length~~ in the cross portion between  
the respective TFT driving wirings.

#### Embodiment 3

Description will hereinafter be given with respect to a solid-state image  
15 pickup device using a MIS-type PD according to Embodiment 3 of the present  
invention.

FIG. 9 is a schematic equivalent circuit diagram of pixels disposed in  
matrix of  $3 \times 3$  of a solid-state image pickup device according to Embodiment 3,  
FIG. 10 is a schematic plan view of one pixel of the solid-state image pickup  
20 device according to this embodiment, FIG. 11 is a schematic plan view of four  
pixels of the solid-state image pickup device according to this embodiment, and  
FIG. 12 is a schematic cross-sectional view of the solid-state image pickup device  
according to this embodiment.

The same reference numerals as those in Embodiment 1 indicate the same  
25 components.

In FIGS. 9 and 10, reference numeral 101 designates a MIS-type PD;  
reference numeral 104 designates a signal line; reference numeral 105 designates a

sensor biasing wiring; reference numeral 106 designates a shielding wiring (GND wiring); reference numeral 108 designates a contact hole; reference numeral 109 designates a sensor lower electrode; reference numeral 120 designates a resetting TFT; reference numeral 121 designates a resetting TFT driving wiring; reference numeral 123, a storage capacitor; reference numerals 124 and 125 designate a switching TFT and a reading TFT forming a source follower ("SFA"), respectively; reference numeral 126, a reset wiring; reference numeral 127, a contact hole through which the storage capacitor 123 and the shielding wiring 106 are connected to each other; reference numeral 128, a switching TFT driving wiring; and 130, a reading TFT driving electrode.

FIG. 12 is a schematic cross-sectional view showing a part of the solid-state image pickup device indicated by an arrow in FIG. 10. Reference numeral 110 designates an insulating substrate made of glass or the like; reference numeral 111 designates a gate insulating film made of SiN, SiO<sub>2</sub> or the like; reference numeral 112 designates a first amorphous semiconductor layer made of a-Si or the like; reference numeral 113 designates a first ~~n<sup>+</sup>-type n<sup>+</sup>-type~~ layer (ohmic contact layer); reference numerals 114 and 115 each designate an interlayer insulating film made of SiN, SiO<sub>2</sub>, Benzocyclobutene (BCB), Polyimide (PI) or the like; reference numeral 116 designates an insulating film made of SiN, SiO<sub>2</sub> or the like; reference numeral 117, a second amorphous semiconductor layer made of a-Si or the like; reference numeral 118, a second ~~n<sup>+</sup>-type n<sup>+</sup>-type~~ layer (hole blocking layer) made of microcrystalline silicon, a-Si or the like; reference numeral 119, a transparent electrode layer made of ITO, SnO<sub>2</sub> or the like; reference numeral 122, a source/drain electrode layer of the resetting TFT; reference numeral 129, a source/drain electrode layer of the switching TFT; reference numeral 131, a source/drain electrode layer of the reading TFT; reference numeral 132, a passivation layer made of SiN, PI or the like; reference numeral 133, a contact

hole; reference numeral 134, an adhesion layer; and 135, a phosphor layer.

Note that, in FIG. 12, reference numerals 121, 128, and 130 each designate a gate electrode layer, reference numeral 105 designates a sensor biasing electrode layer, and reference numeral 106 designates a shielding electrode layer.

5           The insulating film 116, the second amorphous semiconductor layer 117, and the second ~~n<sup>+</sup>-type s<sup>+</sup>-type~~ layer 118 constitute a photoelectric conversion layer of the MIS type PD 101. The gate electrode layer 121, the gate insulating film 111 made of SiN, SiO<sub>2</sub> or the like, the first amorphous semiconductor layer 112 made of a-Si or the like, the first ~~n<sup>+</sup>-type s<sup>+</sup>-type~~ layer (ohmic contact layer) 113, and the source/drain electrode layer 122 for the resetting TFT constitute the  
10           resetting TFT 120. The gate electrode layer 128, the gate insulating film 111 made of SiN, SiO<sub>2</sub> or the like, the first amorphous semiconductor layer 112 made of a-Si or the like, the first ~~n<sup>+</sup>-type s<sup>+</sup>-type~~ layer (ohmic contact layer) 113, and the source/drain electrode layer 129 of the switching TFT constitute the switching  
15           TFT 124. The photoelectric conversion layer is formed above the resetting TFT 120 and the switching TFT 124, and hence both the TFTs are covered with the photoelectric conversion layer.

          The shielding electrode layer 106 is disposed so as to be interposed  
20           between the MIS-type PD 101 and the resetting TFT 120, and between the MIS type PD 101 and the switching TFT 124.

          Radiation such as X-rays is made incident from ~~above an upper side in the paper of~~ FIG. 10 to be converted into visible rays of light through the phosphor layer 135. The resultant rays are then converted into electric charges by the MIS type PD 101 to be accumulated in the storage capacitor 123 through the contact  
25           holes 108 and 133. Fluctuation in electric potential corresponding to these accumulated electric charges is caused in the gate electrode of the reading TFT 125. Thereafter, the switching TFT 124 is operated through the switching TFT

driving wiring 128 so that the accumulated electric charges are read out through the signal line 104 connected to one of the source electrode and the drain electrode of the reading TFT 125 to be processed in the signal processing circuit. The resultant analog signal is then subjected to A/D conversion in an A/D conversion circuit, to be outputted. Thereafter, the resetting TFT 120 is operated through the resetting TFT driving wiring 121 connected to the signal processing circuit to reset the storage capacitor 123. ~~At this time, as in this processing the electric potential~~ of the shielding wiring 106 is fixed to a constant electric potential such as GND at all times.

In this embodiment, the shielding wiring 106 disposed below the sensor element is grounded. As a result, even if ~~as the~~ electric potential of a separate electrode of the sensor element fluctuates, ~~the~~ fluctuation in characteristics due to generation of a leakage current of the TFT element can be suppressed, to allow enhancement of sensitivity to be attained. In addition, since the shielding wiring 106 does not overlap the signal line 104 at all, no parasitic ~~capacity-capacitance~~ is formed between the shielding wiring 106 and the signal line 104, and hence degradation of the sensor sensitivity can also be suppressed.

In this embodiment, there has been shown the specific case where the shielding wiring portion is disposed above the two TFT portions and the storage capacitor portion. However, it is also possible to dispose the shielding wiring portion above three TFT portions and the storage capacitor portion.

In each of ~~the~~ Embodiments 1 to 3 of the present invention described above, there has been shown ~~the~~ specific cases where, in the indirect type solid-state image pickup device, the MIS-type PD is used as the photoelectric conversion element. However, it is also possible to use a PIN-type PD. In case of the PIN-type PD, the photoelectric conversion layer includes a p<sup>+</sup>-type layer, a second amorphous semiconductor layer, and a second n<sup>+</sup>-type layer instead of the

insulating film 116, the second amorphous semiconductor layer 117, and the  
second n<sup>+</sup>-type layer 118, respectively.

#### Embodiment 4

Description will hereinafter be given with respect to a direct type  
5 radiation image pickup device according to Embodiment 4 of the present invention.

FIG. 13 is a schematic cross-sectional view of a direct type radiation  
image pickup device. Reference numeral 110 designates an insulating substrate  
made of glass or the like; reference numeral 111 designates a gate insulating film  
made of SiN, SiO<sub>2</sub> or the like; reference numeral 112 designates a first amorphous  
10 semiconductor layer made of a-Si or the like; reference numeral 113 designates an  
n<sup>+</sup>-type layer (ohmic contact layer); reference numerals 114 and 115 each  
designate an interlayer insulating film made of SiN, SiO<sub>2</sub>, Benzocyclobutene  
(BCB), Polyimide (PI) or the like; reference numeral 120 designates a resetting  
TFT; reference numeral 123 designates a storage capacitor; reference numerals  
15 124 and 125 designate a switching TFT and a reading TFT forming a source  
follower (SFA), respectively; reference numeral 121 designates a resetting TFT  
driving wiring; reference numeral 122, a source/drain electrode layer of the  
resetting TFT; reference numeral 129, a source/drain electrode layer of the  
switching TFT; reference numeral 128, a switching TFT driving wiring; reference  
20 numeral 130, a reading TFT driving electrode; reference numeral 131, a  
source/drain electrode layer of the reading TFT; reference numeral 132, a  
passivation layer made of SiN, PI or the like; reference numeral 133, a contact  
hole; and reference numeral 145, a radiation conversion layer for directly  
converting radiation into electric charges.

25 A circuit diagram of the radiation image pickup device shown in FIG. 13  
is the same as that of FIG. 1 except that the radiation conversion layer 145 is used  
instead of the MIS-type photodiode 101. In the direct type radiation image



pickup device, a-Se, GaAs, CdTe or the like is used as a material of the radiation conversion layer.

Note that, in FIG. 13, reference numerals 121, 128 and 130 each designate a gate electrode layer, reference numeral 105 designates a sensor biasing electrode layer, and reference numeral 106 designates a shielding electrode layer.

A layer structure of the resetting TFT 120 and the reading TFT 124 is the same as that in Embodiment 3. The radiation conversion layer 145 is formed above the resetting TFT 120 and the reading TFT 124, and hence both the TFTs 120 and 124 are covered with the radiation conversion layer 145.

Further, the shielding electrode layer 106 is disposed so as to be interposed between the radiation conversion layer 145 and the resetting TFT 120, and between the radiation conversion layer 145 and the switching TFT 124.

Radiation such as X-rays is made incident from an upper side of the radiation conversion layer shown in FIG. 13<sub>a</sub> to be directly converted into electric charges through the radiation conversion layer 145. The resultant electric charges are then accumulated in the storage capacitor 123 through the contact holes 108 and 133. Fluctuation in electric potential corresponding to the accumulated electric charges is caused in the gate electrode of the reading TFT 125.

Thereafter, the switching TFT 124 is operated through the switching driving wiring 128 so that the accumulated electric charges are read out through the signal line 104 connected to one of the source electrode and the drain electrode of the reading TFT 125 to be processed in a signal processing circuit. The resultant analog signal is then subjected to A/D conversion in an A/D conversion circuit, to be outputted. Thereafter, the resetting TFT 120 is operated through the resetting TFT driving wiring 121 connected to the signal processing circuit to reset the storage capacitor 123. ~~At this time, an~~ In this processing the electric potential of the shielding wiring 106 is fixed to a constant electric potential such as GND at all

times.

While above, the embodiments of the present invention have been described, additional preferred embodiment modes of the present invention will now be enumerated as follows.

5 Embodiment Mode 1

A solid-state image pickup device including a plurality of photoelectric conversion elements and a plurality of switching elements, ~~characterized in that in which~~ the photoelectric conversion element is formed above at least one switching element, and a shielding electrode layer is disposed between the switching  
10 elements and the photoelectric conversion elements.

Embodiment Mode 2

A solid-state image pickup device according to Embodiment Mode 1,  
~~characterized in that in which~~ one photoelectric conversion element and one or more switching elements are disposed in one pixel.

15 Embodiment Mode 3

A solid-state image pickup device according to Embodiment Mode 1 or 2,  
~~characterized in that in which~~ the photoelectric conversion element has a photoelectric conversion layer, and the photoelectric conversion layer includes an insulating layer, a semiconductor layer, and a high impurity concentrated  
20 semiconductor layer.

Embodiment Mode 4

A solid-state image pickup device according to Embodiment Mode 1 or 2,  
~~in which characterized in that~~ the photoelectric conversion element has a photoelectric conversion layer, and the photoelectric conversion layer includes a  
25 first high impurity concentrated semiconductor layer of one conductivity type, a semiconductor layer, and a second high impurity concentrated semiconductor layer of a conductivity type opposite to the one conductivity type of the first high

impurity concentrated semiconductor layer.

#### Embodiment Mode 5

A solid-state image pickup device according to any one of Embodiment  
Modes 1 to 4, ~~in which characterized in that~~ the shielding electrode layer is not  
5 formed above a signal line connected to one of a source electrode and a drain  
electrode of the switching element.

#### Embodiment Mode 6

A solid-state image pickup device according to any one of Embodiment  
Modes 1 to 5, ~~in which characterized in that~~ the shielding electrode layer is held at  
10 a constant electric potential.

#### Embodiment Mode 7

A solid-state image pickup device according to Embodiment Mode 6, ~~in~~  
~~which characterized in that~~ the shielding electrode layer is grounded.

#### Embodiment Mode 8

A solid-state image pickup device according to any one of Embodiment  
15 Modes 1 to 7, ~~in which characterized in that~~ each of the switching elements is  
constituted by a TFT, and the shielding electrode layer is disposed so as to cover  
an upper portion of a channel of each of the TFTs.

#### Embodiment Mode 9

A solid-state image pickup device according to Embodiment Mode 8, ~~in~~  
20 ~~which characterized in that~~ the shielding electrode layer has a width equal to or  
smaller than ~~the channel width-length~~ of the TFT and is disposed so as to cross a  
TFT driving wiring.

#### Embodiment Mode 10

A solid-state image pickup device according to any one of Embodiment  
25 Modes 1 to 9, ~~in which characterized in that~~ the shielding electrode layer is made  
of a high melting point metal.

#### Embodiment Mode 11

A solid-state image pickup device according to Embodiment Mode 10, ~~in which characterized in that~~ the shielding electrode layer is made of molybdenum (Mo), chromium (Cr), titanium (Ti), tungsten (W), or molybdenum-tungsten (MoW).

#### Embodiment Mode 12

A solid-state image pickup device according to Embodiment Mode 1, ~~in which characterized in that~~ the shielding electrode layer is an electrode layer thinner than each of a gate electrode layer, a source/drain electrode layer, and a sensor biasing electrode layer.

#### Embodiment Mode 13

A solid-state image pickup device according to Embodiment Mode 1, ~~in which characterized in that~~ the solid-state image pickup device includes a gate electrode layer, a gate insulating layer, a first amorphous semiconductor layer, a first n-type semiconductor layer, a source/drain electrode layer, a first interlayer insulating layer, the shielding electrode layer, a second interlayer insulating layer, a sensor lower electrode layer, an insulating layer, a second amorphous semiconductor layer, a second n-type semiconductor layer, a transparent electrode layer, and a sensor biasing electrode layer.

#### Embodiment Mode 14

A solid-state image pickup device according to Embodiment Mode 13, ~~in which characterized in that~~ one photoelectric conversion element and one or more TFTs are disposed in one pixel.

#### Embodiment Mode 15

A radiation image pickup device, ~~in which characterized in that~~ a wavelength conversion unit is disposed above the photoelectric conversion element in the solid-state image pickup device as described in any one of

Embodiment Modes 1 to 9.

Embodiment Mode 16

A radiation image pickup device according to Embodiment Mode 15, in  
which characterized in that one photoelectric conversion element and one or more  
5 switching elements are disposed in one pixel.

Embodiment Mode 17

A radiation image pickup device including a radiation conversion layer  
for directly converting radiation into electric charges, and a plurality of switching  
elements, in which characterized in that the radiation conversion layer is formed  
10 above one or more switching elements, and a shielding electrode layer is disposed  
between the switching elements and the radiation conversion layer.

Embodiment Mode 18

A radiation image pickup device according to Embodiment Mode 17, in  
which characterized in that the radiation image pickup device includes a gate  
15 electrode layer, a gate insulating layer, a first amorphous semiconductor layer, a  
first n-type semiconductor layer, a source/drain electrode layer, a first interlayer  
insulating layer, the shielding electrode layer, a second interlayer insulating layer,  
a sensor lower electrode layer, a radiation conversion layer, and a sensor biasing  
electrode layer.

20 As set forth hereinabove, according to the present invention, even if  
fluctuation in electric potential of the separate electrode of the sensor element is  
caused, the fluctuation in characteristics due to generation of a leakage current of  
the switching element can be suppressed by provision of the shielding wiring  
disposed below the sensor element, to allow enhancement of sensitivity to be  
25 attained. Moreover, since the shielding wiring does not overlap the signal line at  
all, a parasitic capacity-capacitance formed between the shielding wiring and the  
signal line can be reduced to allow the degradation as well of the sensor sensitivity

to be suppressed.

5 | In addition, the shielding wiring having ~~the a~~ width smaller than the  
channel ~~width-length~~ is used in the cross portion between the shielding wiring and  
the driving wiring of the switching element ~~is used~~ to allow the gate wiring  
~~capacity as well capacitance also~~ to be reduced.

As many apparently widely different embodiments of the present  
invention can be made without departing from the spirit and scope thereof, it is to  
be understood that the invention is not limited to the specific embodiments thereof  
except as defined in the claims.

# ABSTRACT

A solid-state image pickup device according to the present invention has a plurality of photoelectric conversion elements and a plurality of switching elements, ~~characterized in that~~ The photoelectric conversion element is formed above at least one switching element, and a shielding electrode layer is disposed between the switching elements and the photoelectric conversion elements.

Further, a radiation image pickup device according to the present invention has a radiation conversion layer for directly converting radiation into electric charges, and a plurality of switching elements, ~~and is characterized in that~~ has the radiation conversion layer is formed above one or more switching elements, and a shielding electrode layer is disposed between the switching elements and the radiation conversion layer.